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New PointFocusing Monochromator

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using a 6292 P.M. tube are illustrated in Fig. 1. The ratio of the most probable pulse height of the light and heavy fragments, ploted on a millivolt scale, is about 1.5. This is close to the ratio of their most probable kinetic energies. However, the most probable value of the kinetic energy of fission obtained by comparison with U^{234} α particles is too high in contrast to the behavior of solid scintillators.[2]

This may be the result of fission fragments having a somewhat higher efficiency for the production of light. The alternative is that the result may be the consequence of the difference in behavior of dE/dx for fission fragments and α particles. The scintillation produced by the fission fragments will approximate a point source more closely than will the α scintillations. The centroid of light intensity produced by the fission scintillations will be much closer to the source than the corresponding centroid of the α-particles.

We have attempted to ascertain the timewise properties of the scintillations by photographing pulses from the RCA 6342 photomultiplier on a Tektronix 517 Oscilloscope amplified by a single Hewlett-Packard model 460A traveling wave amplifier. The rise time of the pulse appears to be limited by the oscilloscope. We infer that it must be less than 10^{-8} sec. The pulses have a width of $2\text{–}3\times10^{-8}$ sec at half maximum. Indication of a definite decay time is clear but it is not possible to resolve it with this equipment.

We have obtained a 20 percent resolution on the U^{234} α peak with krypton. Although the gas used was "spectroscopic grade" and was passed through the chamber continuously, we believe that better resolution could be obtained by purification of the gas. The presence of organic vapors has a drastic effect on pulse height.

We have observed the same phenomena with argon. The results obtained were essentially the same as with krypton except that the pulse heights were much inferior.

We are grateful to the Water Boiler Group for the use of their facilities.

* Work performed under the auspices of the U. S. Atomic Energy Commission.

[1] C. Eggler and C. M. Huddleston, Phys. Rev. 95, 600 (1954).
[2] J. C. D. Milton and J. S. Fraser, Phys. Rev. 90, 388 (1953).

Effect of Feedback on Noise in a Pulse Amplifier

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I WOULD like to call attention to an error in the article entitled "A minimal noise preamplifier for proportional counters and similar applications" by K. Enslein and B. Brainerd.[1] This is worth mentioning because it is a rather popular misconception and is indicative of a tendency to expect much too much from negative feedback.

The preamplifier described uses a triode as the input tube at low gain (about 1.5) to keep the input Miller effect capacitance small. The claim is made that the noise contribution of the second stage is unimportant because that stage is inside the feedback loop and its noise contribution, therefore, is attenuated by the feedback factor. I would like to demonstrate that in a negative feedback amplifier, as in any amplifier, the second stage noise contribution is less than that of the first stage by just the gain factor of the first stage.

If the internal gain of a negative feedback amplifier is represented by K and the feedback factor by β, then the over-all gain with feedback, G, is given by the well-known expression

$$G=\frac{K}{1+\beta K}. \tag{1}$$

If the gain of the first stage is represented by K_1, and the gain of all the other stages by K_2, then $K=K_1K_2$ and Eq. (1) may be rewritten

$$G=\frac{K_1K_2}{1+\beta K_1K_2}.$$

With respect to a noise signal introduced at the second stage the same amplifier can be considered to have an internal gain K_2 and a feedback factor βK_1. The gain with respect to the second stage G' is, then,

$$G'=\frac{K_2}{1+\beta K_1K_2}.$$

The ratio of G to G' is seen to be K_1 which is the gain of the first stage.

In the amplifier described by Enslein and Brainerd the noise contribution of the second stage is $\frac{2}{3}$ of that contributed by the first stage rather than 6 percent as they claim. However, since uncorrelated noise voltages combine as the root mean square, the resultant noise due to the first two stages is only 20 percent greater than that due to the first stage alone.

[1] K. Enslein and B. Brainerd, Rev. Sci. Instr. 24, 916 (1953).

New Point-Focusing Monochromator*

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A NUMBER of crystal type point-focusing x-ray monochromators have been designed, which use either two cylindrically bent crystals[1] or one crystal deformed into a non-

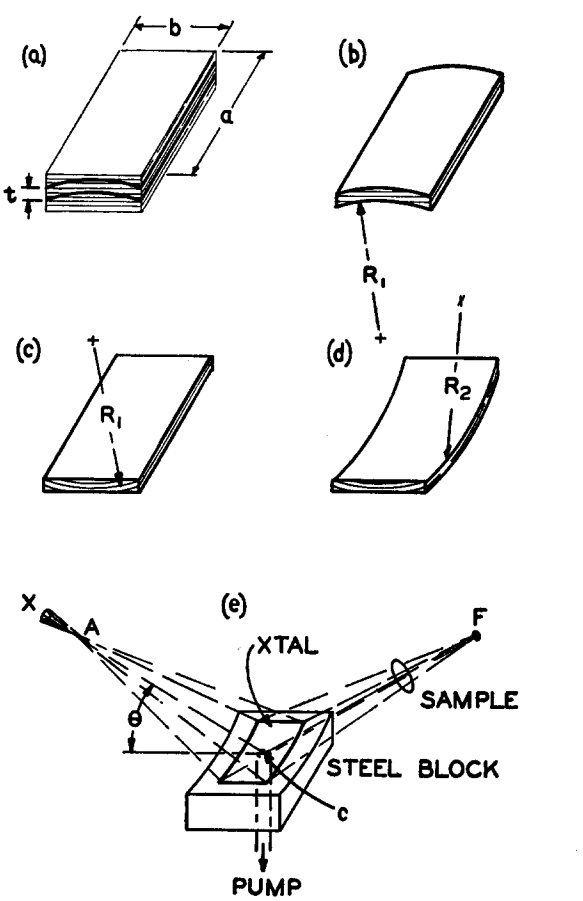

FIG. 1. Process of making a single-crystal monochromator. (a) Original block of quartz: $w=3.8$ cm, $l=7.6$ cm, $t=0.025$ cm. (b) Finished lamina: $R_1=105$ cm. (c) Flattened lamina. (d) Final shape: $R_2=R_1\sin^2\theta=95$ cm. (e) Mounting and x-ray beam: $\langle AC\rangle=\langle CF\rangle=R_1\sin\theta$, $\theta=71°42'$.

developable surface.[2] The first type produces a point focus of very low intensity because it requires two successive reflections of the beam. In the second type, the strains produced by bending to a nondevelopable surface often introduce deformations in the crystal structure which seriously limit the sharpness of the focus.

A method is described here for cutting and bending a single crystal for a point-focusing monochromator which does not produce a nondevelopable surface.

A thin cylindrical lamina of radius R_1 is cut from a piece of flawless quartz [Fig. 1, (a) and (b)]. The lamina is then pressed flat, so that the crystal planes themselves are bent to a radius of curvature R_1 [Fig. 1, (c)]. Finally the flattened lamina is bent to conform to a cylindrical surface of radius R_2, the axis of which is perpendicular to the axis of the first cylinder [Fig. 1, (d)].

The x-ray source is placed at X behind a small aperture A, and a point focus is produced at F [Fig. 1,(e)]. The point focus is an image of the aperture so that the beam intensity is essentially determined by the size of the aperture.

The final cylindrical surface is obtained in the following manner. The crystal is laid on a stainless steel block which is ground and lapped to a radius R_2. The edges of the crystal are sealed to the steel block with beeswax, and the space between the crystal and the block is evacuated through a very small hole in the block [Fig. 1,(e)]. The atmospheric pressure is then sufficient to hold the crystal in contact with the block. This method of mounting the crystal proved to be far superior to clamping it between two frames.

Thus far the smallest diameter obtained for the point focus is a few tenths of a millimeter, so that an aperture of about a 0.25-mm diameter gives almost maximum resolution. Using this aperture, diffraction patterns of oriented collagen chains were visible out to the fourth order in exposures of less than two hours, or about one-fiftieth the time required for a comparable exposure using the same sample and x-ray source with a two-crystal monochromator.[3] The size of the focal spot is about twice that of the two-crystal monochromator, but it is several times as large as can be accounted for by geometrical aberrations. Hence one should be able to improve the resolution by using more accurate cylinders.

* Work supported by contract with the Office of Naval Research.

[1] For example, Shenfil, Danielson, and DuMond, J. Appl. Phys. 23, 854–9 (1952).

[2] For example, J. Despujols, Compt. rend. 235, 716–8 (1952); Hagg and Karlsson, Acta Cryst. 6, 728–30 (1952).

[3] The instrument used was that described in reference 1.

Improvement in Rubber Diaphragm Cloud-Chamber Technique*

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It is standard practice with rubber diaphragm expansion cloud chambers to employ a velvet baffle which serves to damp the gas motion and reduce turbulent distortion of tracks. The velvet is usually supported on a perforated metal plate located between the illuminated region and the rubber diaphragm. The resistance offered by the velvet makes necessary the production of a higher supersaturation ratio behind the velvet, for ideal conditions in the illuminated region. This overexpansion may, in cases of thick velvet and high ionization levels, produce very high fog density behind the velvet, which in turn may influence the general cleaning operations found necessary to give good contrast in the illuminated region.

We have found the presence of a clearing field electrode between the velvet grid and the rubber diaphragm helpful in this connection. This was observed in a rubber diaphragm chamber 1 m in diameter and 20 cm deep exposed to the intense radiation of the Brookhaven cosmotron. Although no quantitative data were obtained, the result of insertion of a below-diaphragm electrode has been dramatic enough to report here. Whereas previously, we were forced to use a 2½-minute operating cycle on a 1/10-of-full beam intensity to obtain good contrast, it is now possible to photograph at full beam intensity (although the number of tracks makes scanning too difficult) with a repetition cycle of 1 to 1½ minutes. We have used a wire mesh electrode operating at from 200–600 volts with good effect. If, during the full intensity operation, the voltage is removed, fog build-up commences and after two or three expansions the chamber is unusable.

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Laboratory and Shop Notes

Brief contributions in any field of instrumentation or technique within the field of the Journal can be accorded earlier publication if submitted for this section. Contributions should in general not exceed 500 words, and no proof will be shown to the authors.

Glass Ball Valves

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(Received September 28, 1954)

In our research we required some all-glass check valves and float valves for use with mercury. As a ball valve seats by rolling rather than by sliding, it is less likely to stick than other types. Accordingly a process of grinding glass spheres and spherical seats was developed.

The first step is to make a reasonably spherical blob of glass 0.02 in. or more larger than the intended ball. The exact oversize required depends on the out-of-roundness of the blob, which in turn depends on the skill of the glass worker. The blob is produced by softening the end of a glass cane in a flame. The softened glass gathers into a crude ball which grows in size as the cane is fed into it. With careful manipulation a ball over ¼ in. in diameter can be grown, though the larger it is, of course, the harder it will be to control. The ball is made as spherical as possible by heating it and allowing surface tension to produce a spherical shape. Surface tension can be assisted by gravity, because if the ball is held up with the cane below it it will flatten, and if it is suspended with the cane above it it will lengthen. It is then allowed to cool until no longer soft. A second cane is heated until quite soft and stuck to the ball on the opposite side from the original cane. The junction of the original cane and the ball is then heated and the cane pulled off, leaving as little excess glass as possible. The lump thus formed is smoothed out by heating that part of the ball, and finally the ball is worked to spherical shape in the same manner as before, although this time extra care must be taken not to heat the cane any more than necessary. The ball is then allowed to cool and the cane is broken off. It should break off leaving a very slight indentation in the surface of the ball. The ball can then be annealed if desired.

Solid balls are easier to make than hollow balls, though we have made the latter as well. A ball light enough to float on water should be possible to make, though of course it would be fragile.

The first stage in grinding is to grind off any of the remains of the manipulating cane. This can be done by hand with coarse carborundum (200 mesh) spread on a glass plate. Next, a thick rubber sheet is spread with a paste of coarse carborundum. A piece of glass tubing whose o.d. is equal to or slightly smaller than the diameter of the ball is ground square on the end, again using the glass plate. The ball is then rolled around the rubber sheet by means of the glass tube as if one were using a ball pen. The carborundum is carried by the ball from the rubber sheet up to